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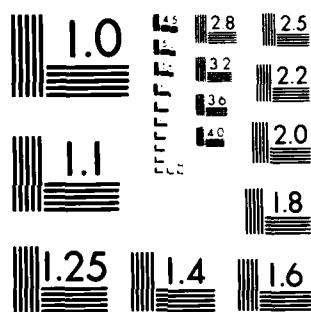
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(Selected Articles)



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GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

Note of the Editor: This paper is the major content of the report made by Professor J.O. Edstrom when he visited our country as the leader of the Swedish Metallurgical Representatives in 1981. Because there is a shortage of coal in Sweden, but hydroelectric power is abundant, they have carried out a great deal of research and development work in the production of sponge iron using the plasma technology in order to conserve coal (coke). This paper introduces these new technologies. Furthermore, a meaningful economic comparison of the technologies was performed. Therefore, the key points were translated for reference in our country. In order to conserve the page number, the part involving the comparison of other modern methods to produce sponge iron in the original paper was deleted by the editor.

NEW IRONMAKING TECHNOLOGY

In this century, since the fifties, many countries including Sweden have done a great deal of research in search of a low cost, small batch process, and minimum pollution ironmaking method which does not require the use of sintering and coking. The methods to be discussed in this paper include the Swedish ELRED method, the INRED method, the PLASMAMELT method, and PLASMARED method, etc.

1. The PLASMARED Method

This method was developed by the Swedish SKF Company (Ball Steel Company). It was used to reform the original Wiberg-Söderfors sponge iron workshop.

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The use of the plasma heating technology in the production of sponge iron would allow the use of various types of fuels such as natural gas, liquified petroleum gas, heavy oil, kerosene slurry, or coal powder to replace coke as the reducing agent and the fuel. Figures 1 and 2 are the flow diagrams of the original WIBERG-SÖDERFORS method and the PLASMARED method, respectively.

Figure 1. The Original WIBERG-SÖDERFORS Method

1. Electric Power; 2. Coke; 3. Dolomite; 4. Residual Coal Gas; 5. Pellet; 6. Air; 7. Smoke; 8. Sponge Iron Vertical Reduction Furnace; 9. Used Dolomite Desulfurizer; 10. Carbonizer for Used Coke (regeneration of coal gas).

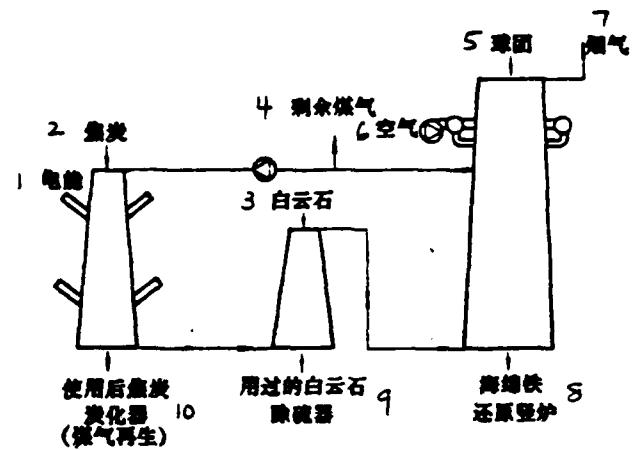
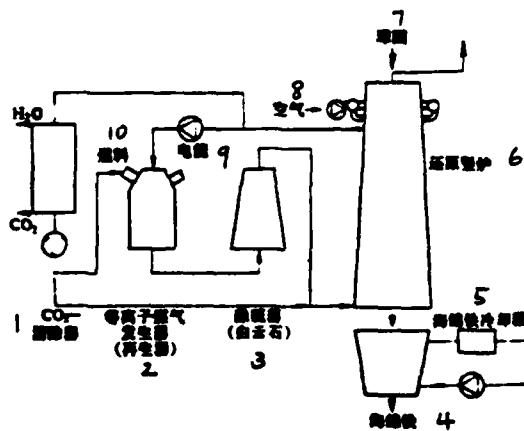


Figure 2. The PLASMARED Method (the Improved WIBERG-SÖDERFORS Workshop)

1. CO_2 -remover; 2. Plasma Coal Gas Generator (regenerator); 3. Desulfurizer (dolomite); 4. Sponge Iron; 5. Sponge Iron Cooling Apparatus; 6. Reduction Vertical Furnace; 7. Pellets; 8. Air; 9. Electric Power; 10. Fuel.



The apparatus to convert the fuel into a reductive gas is a plasma arc heating device. It is capable of efficiently transferring large amounts of energy under the conditions of a reductive atmosphere and high temperature. The plasma heater is essentially an electric arc combusting between two electrodes.

Almost any kind of coal gas and coal gas mixture can be heated to the required temperature after passing through the electric arc heater. The amount of energy transferred to the coal gas can research 10 KWh/m³. The plasma electric arc heater has the following characteristics related to the smelting process.

The high energy releasing intensity allows it to work regardless of the oxidation state. It can be easily and accurately adjusted.

Table 1. Comparison of the Calculated Energy Consumption of the PLASMARED Method and the Actual Energy Consumption of the WIBERG-SÖDERFORS Method.

(Each Ton of Sponge Iron)

1. Electricity, KWh; 2. Coke, Kg; 3. Heavy Oil, Kg;
4. Liquified Petroleum gas, Kg; 5. Coal, Kg;
6. Natural Gas, Gcal; 7. Total Energy, Gjoule;
8. MIDREX Method; 9. WIBERG-SÖDERFORS Method;
10. PLASMARED (liquified petroleum gas); 11. PLASMARED (heavy oil); 12. PLASMARED (gasified coal);
13. PLASMARED (natural gas).

	MIDREX 法	WIBERG- SÖDERFORS法	PLASMARED /10 (石油液化气)	PLASMARED /11 (重油)	PLASMARED /12 (气煤)	PLASMARED /13 (天然气)
1. 电, kWh	105	960	880	940	930	860
2. 焦炭, kg	—	210	—	—	—	—
3. 重油, kg	—	—	—	150	—	—
4. 石油液化气, kg	—	—	131	—	—	—
5. 煤, kg	—	—	—	—	200	—
6. 天然气, Gcal	2.5	—	—	—	—	1.35
7. 总能量, Gcal	10.9	9.6	9.2	9.6	9.2	8.6
	2.6	2.3	2.2	2.3	2.2	2.1

The WIBERG-SÖDERFORS Method is a vertical furnace sponge iron method. 2/3 of the reductive gas generated by the FeO reduction segment is recycled. Then, it passes through a carbonization reaction to transform to a lower oxidation state again. The remaining coal gas is used to pre-reduce higher valent iron oxides to convert them to FeO. Through the use of the recycled coal gas generated by the reduction of FeO, the energy consumption is reduced to the lowest extent possible. The use of a plasma electric arc heater to replace the resistance heating of coke in the WIBERG-SÖDERFORS method makes the PLASMARED furnace reach an even higher coal gas conversion capability. Furthermore, the carbonization efficiency of the coal gas is greatly increased. In the heater, a small amount of recycled gas passes through the plasma arc and is heated to 4000 - 5000K. Most of the circulating gas is blown into the plasma furnace in front of the heater after passing through the loop of the heater. Then, all the coal gas passes through the reaction chamber. The reaction is completed there and an equilibrium is nearly reached. The converter of this type can almost use any fuel without the need of a catalyst. It is very easy to obtain a coal gas containing less than 2-3% of CO₂ or H₂O. /60

Since January 1981, production has taken place in a workshop with an annual production of 70 thousand tons at Hofors. It uses pellets. Furthermore, it is capable of using various kinds of fuels available in Sweden. The electrical arc heater, plasma conversion system is suited for almost all the gas reduction process such as MIDREX, HYLIII, etc.

2. The KRUPP Revolving Furnace Smelting Method

Before we discuss the production of molten iron directly from fine iron ore powder, let us first introduce a new technology to smelt scrap steel and sponge iron in a revolving furnace. This new technology was developed by the Fried Krupp Research Institute in Germany. It utilizes low and medium volatile coal powders as the energy source. Its principle is shown in Figure 3. Coal and oxygen are injected into a revolving furnace melting pot to make coal burn partially to produce CO and H₂. The gas formed also created an intense turbulence in the melt. Consequently, the

sponge iron and scrap steel, which are continuously fed from the top of the melting pot are melting at a high rate. The pre-melted product is used to make steel.

Figure 3. Block Diagram of the KRUPP Revolving Furnace Melting Method.

1. Coal Powder;
2. Feeding Equipment;
3. Oxygen;
4. Melting Pot;
5. Added Gasifier;
6. Coal;
7. Steam;
8. Crushed Sponge Iron;
9. Hot Ash Collector;
10. Direct Utilization of Hot Coal Gas;
11. Melted Metal;
12. Post Treatment of Molten Iron;
13. Steel;
14. Heat Exchanger;
15. Cleaning and Compressing of Coal Gas;
16. Utilization of Cold Coal Gas.

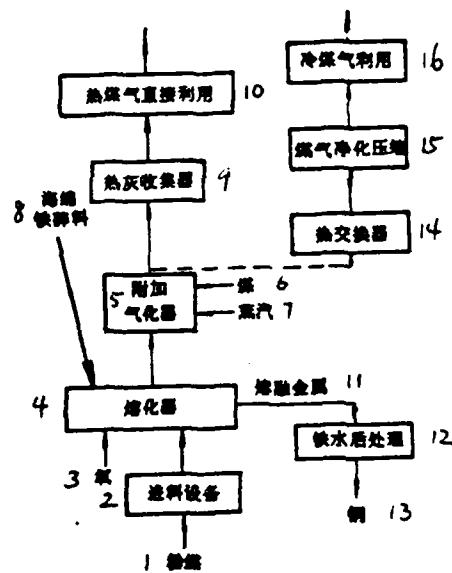
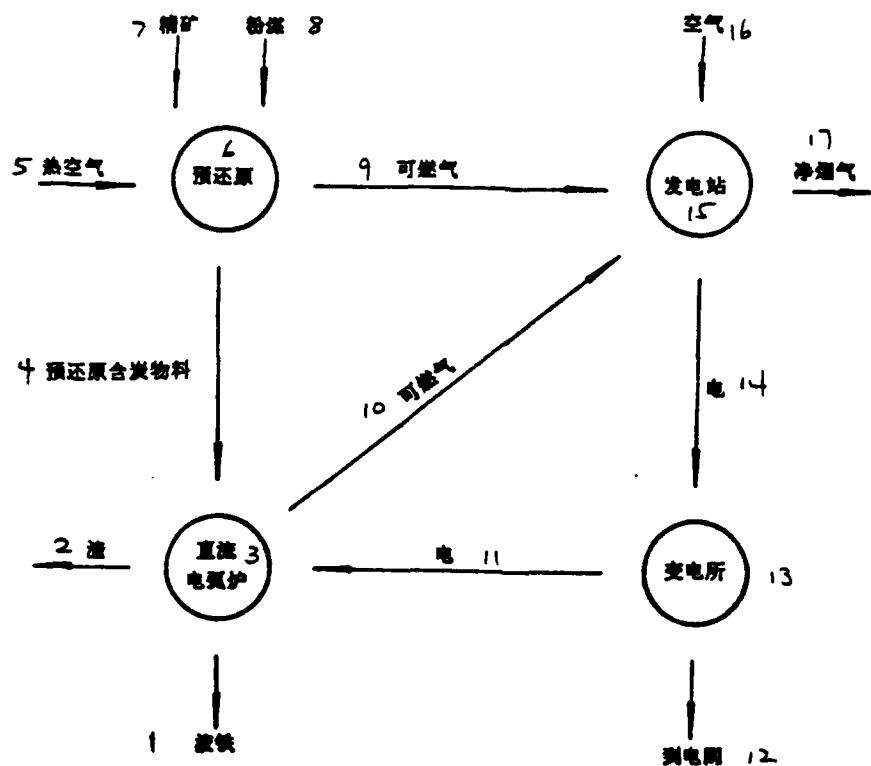


Figure 4. Schematic Diagram of the ELRED Method

1. Liquid Iron; 2. Residue; 3. dc Electric Arc Furnace;
4. Pre-reduced Carbon Containing Material; 5. Hot Air;
6. Pre-reduction; 7. Fine Ore; 8. Coal Powder;
9. Combustible Gas; 10. Combustible Gas; 11. Electricity;
12. To Electrical Network; 13. Electrical Transformer Station;
14. Electricity; 15. Power Generating Station;
16. Air; 17. Cleaned Smoke.



The oxygen used to burn the coal is delivered to the melting pond from the bottom of the melting pot by a nozzle. The fine powdered coal is delivered by the concentric ring nozzle outside the oxygen nozzle using a gas. The coal flow also has the effect of protecting the oxygen nozzle from damage due to burning. /61

The sponge iron or scrap iron is continuously fed into the melting device through gates. The metal produced can be delivered continuously or by the batch. On a piece of three ton scale experimental equipment, the melting rate is $1t/m^3h$. It is

comparable to the highest power electric arc furnace. The gas coming out of the revolving furnace can be directly used to gasify addition coal together with steam. Thus, it is possible to cool the gas down from 1500°C to 1000°C and slightly increase its H₂ content. According to the actual condition of the location, this reductive gas can be used as an industrial fuel gas or a reduction gas to reduce the iron ore into sponge iron. This method can be linked with other methods to produce sponge iron (e.g. the MIDREX method). It is capable of utilizing the heat required by the self-reduction and melting of coal and oxygen.

3. The ELRED Method (the electrical reduction method)

This is a melting reduction method. It was jointly developed by the Stora Kopparbergs Bergslags Company and the ASEA Company in Sweden.

This method has three major processes (Figure 4):

- (a) pre-reduction to 60-70% in the fluidized bed;
- (b) total reduction in the electric arc furnace;
- (c) generating electricity using the waste coal gas.

Raw Materials: Fine ore powder less than 0.3mm, coal (gasified coal), residue making material (lime).

Products: Low silicon, low Mn pig iron containing approximately 4% carbon, residue, electric power.

An experimental set-up was built by ASEA in Västerås. A group of circulating fluidized beds is used to carry out the pre-reduction experiment (Figure 5). The reduction reaction is carried out under 3-4 atmospheres at 950-980°C. Because a fine agglomerate is formed between the pure ore and the porous coke, the adhesion of the reduced iron is prevented. Porous coke is produced by adding coal to a fluidized bed using a suitable method.

The final reduction and melting in the form of pig iron are carried out in a dc electric arc furnace (Figure 6). The pre-reduced materials are delivered into the electric arc furnace through the hollow graphite electrode (or the hollow Söderberg electrode). An electric power plant is built near the iron smelting plant to utilize the heat generated in pre-reduction and final reduction to generate electricity. The electric plant is connected to the electrical power system to deliver the remaining power into the electrical network.

Figure 5. The Pre-reduction Section of the ELRED Method

1. Furnace Material Already Reduced; 2. Coal Gas for Fluidization; 3. Air; 4. Coal; 5. Pure Ore Powder; 6. Smoke.

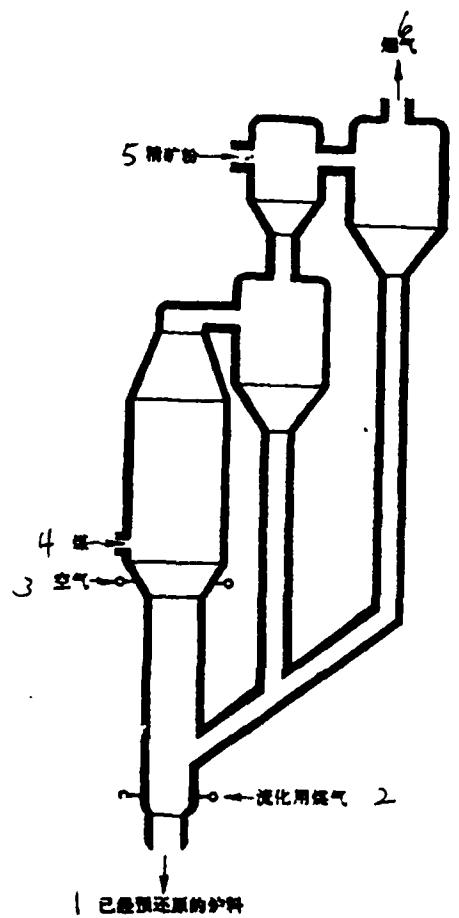
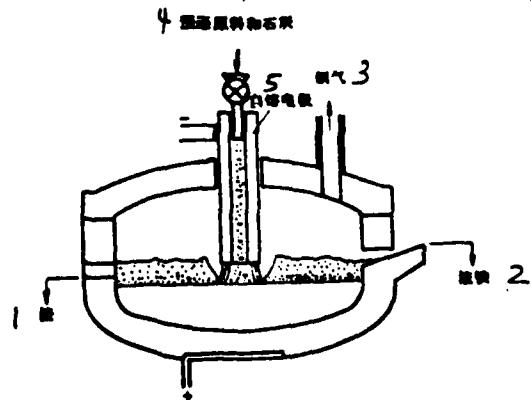


Figure 6. The Final Reduction Process of the ELRED Method

1. Residue; 2. Liquid Iron; 3. Smoke; 4. Pre-reduced Raw Material and Lime; 5. Self-Melting Electrode.



For each ton of iron produced using the ELRED method, it is necessary to use 680 Kg of coal with a calorific value of 6700 Kcal/Kg. In the meantime, it delivers 330 KWh of residue electric power to the electrical network. Therefore, the actual amount of electricity consumed is 4.3×10^9 cal for each ton of pig iron. /62

In terms of a plant which has an annual production capacity of 1 million tons, comparing a steel smelting plant using a revolving furnace with pre-reduction + melting reduction + power plant + oxygen blowing to a steel smelting plant using a coke furnace + a sintering plant + a tall furnace + a power plant + an oxygen blowing revolving furnace, the annual investment for each ton of crude steel is almost the same. However, the ELRED method uses the fine pure powder to replace the sintered ore, and gasified coal instead of coke. It is capable of producing pig iron cheaper as compared with the tall furnace method by 100-150 Swedish Kronas (25-35 U.S. Dollars) per ton.

4. The INRED Method

Boliden is the major non-ferrous metal industry in Sweden. The reason for its developing a new iron making method was due to the difficulty of the company in selling the pyrite slag. The pyrite slag is a fine iron oxide particle. Its structure and particle size make it difficult to sinter. It is also not possible to use the tall furnace.

This technology was tested using a piece of experimental equipment in a metallurgical research institute at Lulea in northern Sweden on a scale of 3-4 t/h. It was estimated that a 8-9 t/h experimental set-up will be built in 1981.

The INRED method has its significance in the production of pig iron from finely ground pure ore and the recovery of the gas ash of an iron smelting plant. The objectives of the effort at Boliden are as follows:

- (a) the product is pig iron;
- (b) iron oxides are not sintered;
- (c) materials containing impurities such as sulfur, zinc, lead, and antimony can be used;

- (d) coal is the major reducing agent and fuel;
- (e) very limited additional electric power supply;
- (f) reducing the separation steps;
- (g) minimizing the volume of the waste gas.

The INRED method is to carry out the reactions in two separate sections of the same reactor. The first section is to pre-reduce the higher valent iron compounds by flash smelting in the combustion chamber back to FeO. This combustion chamber is protected by cooling. The fuel supplied is partially burnt. The other portion is converted into coke. The second section is to collect the pre-reduced furnace material and coke into another electrically heated furnace. This is an electric arc furnace downstream from the combustion chamber. Pig iron is produced in this furnace. This method is illustrated in Figure 7-9.

Figure 7. Schematic Diagram of the INRED Method

1. Pure Ore Powder; 2. Powdered Coal; 3. Smoke;
4. Residue; 5. Flash Smelting Pre-reduction;
6. Electrical Smelting for the Final Reduction;
7. Iron Liquid; 8. Oxygen; 9. Steam; 10. Electrical Energy;
11. To the Electric Network; 12. Oxygen Producing Plant;
13. Turbine; 14. Power Generator.

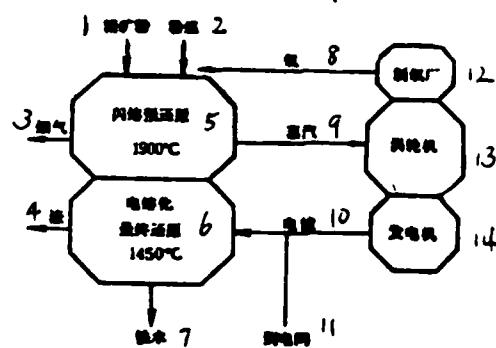


Figure 8. The Reduction Furnace in the INRED Method

1. Oxygen; 2. Pure Ore Powder; 3. Coal;
4. Third Order Oxygen; 5. Secondary Oxygen.

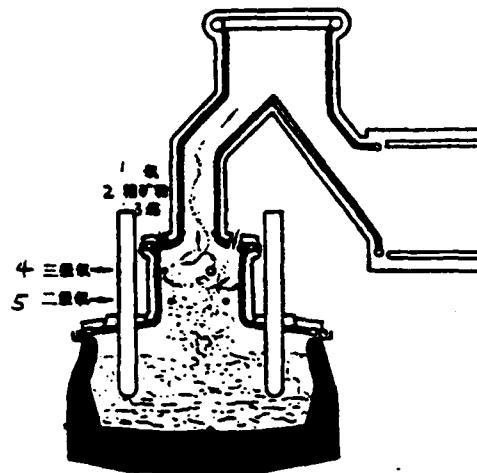
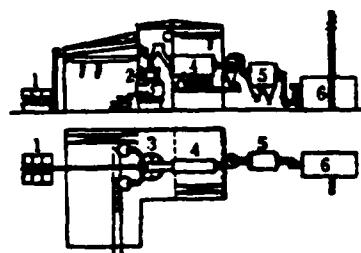


Figure 9. Diagram of the Set-up in a Shop Using the INRED Method

- 1-Preparation of the Furnace Material;
- 2-The Flash Smelting Chamber;
- 3-Electrical Furnace;
- 4-Smoke Boiler;
- 5-Electrical Dust Remover;
- 6-Recovery of Clean Coal Gas.



The flash smelting and pre-reduction can also be matched with various final reduction and smelting methods.

The wall of the flash smelting chamber and the coal gas outlet at the center of the chamber top are made of boiler pipe. The wall is coated with a solid protective layer. The furnace charge and a portion of the oxygen are sprayed down from the nozzle at the top of the flash smelting chamber. The nozzle points at a fixed direction. Thus, a whirlpool is formed due to the mutual interaction of the injected stream. The flash smelting takes place right at that spot. The flash smelting method uses fine particles of iron oxide, coal, crushed lime stone, and oxygen. Because the injected steam is encountering the rising hot coal gas, the combustion is very rapid. The energy is also released very rapidly in the hot whirlpool. The iron oxides are melted and partially reduced. A portion of the coal is burnt. The remaining coal forms coke. The lime stone is roasted.

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When the smelted iron oxide is lowered to the surface of the material in the final reduction furnace, it has already been reduced to FeO. Its temperature rises to approximately 1600°C. At that spot, the FeO is further reduced to iron by the coke. Furthermore, the temperature is lowered. The material becomes a plastic paste. The coal gas generated in the flash smelting section and the final reduction reaction is completely burnt at the top of the flash smelting furnace using secondary oxygen. The heat produced, in addition to heating the materials, is sufficient to supply the needs for generating electricity and producing oxygen. The additional energy required for the final reduction and melting is supplied by the electricity generated by the waste gas.

According to an estimation, the energy consumption in producing a ton of iron using the INRED method is 635 Kg of coal (the water content is 6% and ash content is 20% in the coal), which corresponds to 4.1×10^9 cal/t of iron. The final reduction furnace only requires approximately 300 KWh/t of iron in energy. The thermal efficiency is 65-70%.

The technological control has two requirements: 1) the carbon content in the furnace should be maintained constant, and 2) enough coal should be burnt to generate electricity in order to ensure the electrical energy required by the technological process.

The rate of supplying the raw material must keep the height of the furnace charge constant at the top of the induction furnace. A computer program controlled process should be used to maintain the carbon equilibrium. The program controlled techniques include: the relative matching of two types of coal with different reactivities, the relative matching of chunk coal, and powdered coal, and the distribution of oxygen between the primary nozzle and the horizontal final combustion secondary nozzle.

Experiments to date indicate that the iron produced by the INRED method has a relatively low carbon content and a high silicon to carbon content as compared to the pig iron produced by the blast furnace. The approximate assay of iron shows 2.5-3% C and 0.5-1% Si. The P and S contents in the iron are determined by the contents of these elements in the furnace charge. Alakali metals are not a problem in this method. Cyanides will not be formed. Zn and Pb are evaporated and collected in the coal gas dust removal equipment.

The economic advantages of the INRED method and the ELRED method are consistent. The savings in fuel for each ton of iron is about 50 Swedish Kronas. The savings in the mineral materials is approximately 60-100 Swedish Kronas.

5. The PLASMAMELT Method

This method is illustrated in Figures 10-11. The smelting reducing zone is located in the furnace chamber filled with coke. It is similar to the combustion zone at the tuyere of a blast furnace. The prereduced pure iron ore, the slag producing material, /64

Figure 10. The Correlation Between the Theoretical Amounts of Electric Energy, Coal, and Coke Consumed for Each Ton of Molten Iron (containing 4% Carbon) and the Degree of Pre-reduction.

1. Electric Energy, Kwh; 2. Coal, Coke, Kg; 3. Degree of Pre-reduction %; 4. Coal; 5. Electricity; 6. Coke.

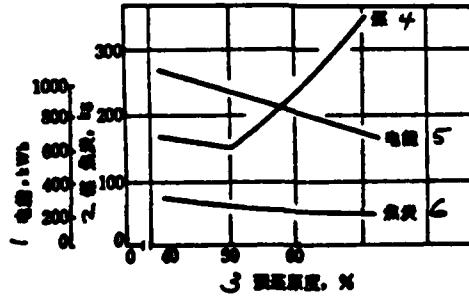


Figure 11. The PLASMAMELT (plasma melting) Method

1. Coke; 2. Smelting Reduction; 3. Furnace Slag;
4. Molten Iron; 5. Plasma Generator; 6. Producing
- Coal Gas; 7. Pre-reduced Ore; 8. Coal Gas;
9. Pressure Control; 10. Slag Generating Material;
10. Coal Powder; 12. Compressor; 13. Pre-reduction;
14. Dry Pure Iron Ore Powder; 15. Drier and Rock
- Remover.

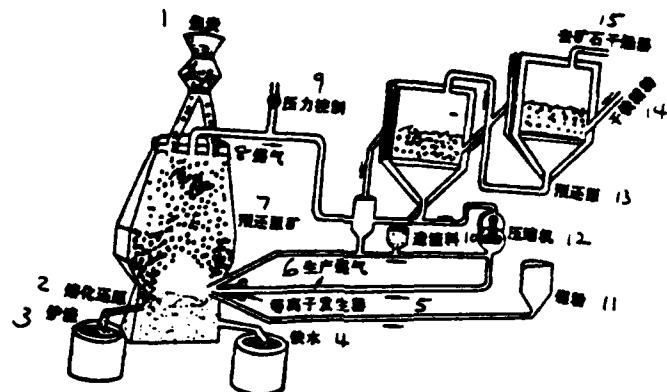
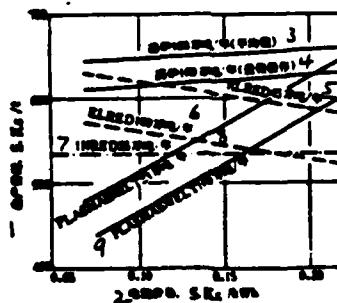


Figure 12. The Costs of Molten Iron at Various Electricity Prices
(under the prices at the end of 1979 in Sweden)

1. Production Cost S.Kr/t;
2. Cost of Electricity S.Kr/KWh;
3. Blast Furnace - 1 million tons/year (average value);
4. Blast Furnace 1 million tons/year (optimum);
5. ELRED 450 thousand tons/year;
6. ELRED 1 million tons/year;
7. INRED 350 thousand tons/year;
8. PLASMAMELT 230 thousand tons/year;
9. PLASMAMELT 1 million tons/year.



and the reducing agent (powdered coal, heavy oil) are injected into the smelting reducing zone. At the same time, heat is supplied by the plasma generator. The gas temperature in the plasma generator is between 3000-5000°C. However, because of the strong endothermic reduction reaction, the temperature of the coal gas rapidly decreases to 1700-2000°C in the actual reduction zone outside the plasma generator. The temperature of the pre-reduction section is about 750°C. The raw material very quickly passes through the 950-1500°C dangerous zone in the reduction section. When the pre-reduced pure ore is injected into the smelting reduction zone, it is immediately melted and the final reduction takes place. The molten iron and furnace slag sink to the bottom of the furnace. The slag and the iron are discharged using the same method as in a blast furnace. The coal gas released by the furnace is a pure mixture of CO and H₂. Its temperature reaches 1000-1200°C. The major reducing agents are coal and oil. The coke in the furnace chamber of the final reduction furnace forms a reduction chamber, which permits gases and liquids to pass through, and is resistant to high temperatures. The coke is also used to ensure the reducing condition of the fire resistant wall. When the amount of reducing agent injected fluctuates by a small quantity, it compensates so that the pig iron produced has a stable carbon content. The mixture of CO and H₂ leaves the furnace. It is then cooled to the temperature suitable for pre-reduction (approximately 800°C). The dust is removed in a rotating dust remover. It is then sent to the pre-reduction section. Because the smelting reduction section is a completely air tight system, the furnace gas can increase to the required pressure. A small portion of the furnace coal gas coming from the final reduction furnace is cooled and compressed. A part of it is used in the plasma generator to generate coal gas. The other part is injected into the furnace after passing through the pre-reduced pure iron ore powder and the slag making material.

The pre-reduction section is formed by two serially connected conventional fluidized bed systems. Under the temperature range of 700-800°C, 50-60% of the iron oxides are reduced. When the gas leaves the pre-reduction section, it still contains 10-15% of CO + H₂, which can be used to dry and pre-heat the pure iron ore powder.

In fact, when the pre-reduction reaches 50%, it is anticipated that the energy consumption shown in Table 2 can be realized. For convenience, the table also lists the energy consumption values of the conventional blast furnace.

Table 2. Energy Consumption Per Ton of Iron for Pig Iron Containing 4% Carbon.

1. Method; 2. Coke, Kg; 3. Coal, Kg; 4. Oil, Kg;
5. Electric Energy (KWh); 6. Gjoule; 7. Blast Furnace;
8. PLASMAELT (coal); 9. PLASMAELT (oil).

方法	2 kg	3 kg	4 kg	5 5 (kWh)	6 Gjoule	7 Gcal
高炉 7	440	—	40	75	14.8	3.5
PLASMAELT (煤) 8	50	200	—	1120	11.3	2.7
PLASMAELT (油) 9	50	—	140	1080	11.3	2.7

In which the consumption of coal was calculated based on coal containing 9% water and 10% ash.

It was projected that the tests on a 1.5 MW set-up were to be completed in 1980. The next step is to build a piece of 15 MW equipment capable of producing 60-70 thousand tons of pig iron per year.

6. The Economic Comparisons of the New Technologies

According to calculation, the investment of the ELRED method is far greater than those for the PLASMAELT and the INRED method. Especially for a small scale production, this method has no advantage at all. Under the specific pricing condition in Sweden, when the electricity rate is lower than 0.3 Swedish Krona/KWh, it is much more economical to use the INRED method than the ELRED method. When the electricity rate is lower than 0.17-0.18 Swedish Krona/KWh, and assuming both methods can produce according to the designed consumption indicators and productivities, it costs less for a plant which produces less than 500 thousand tons to use the

PLASMAMELT method than the ELRED method. The construction investment of the PLASMAMELT method will be greatly lower than that of the ELRED method. It will be slightly lower than the INRED method.

The costs of pig iron including the basic investments using these new technologies are 15% less than that of a blast furnace producing 1 million tons per year. Figure 12 is a comparison of the variations of the costs of pig iron produced by various methods using the price of electrical energy as a variable. It includes a comparison of productivity.

In order to study and develop a new ironmaking method which can compete with the blast furnace method and various sponge iron methods, we should develop those ironmaking methods which are based on certain modern fundamental technologies and cannot be used in present ironmaking methods. The present ironmaking methods have almost reached perfection after a long period of time of hard work.

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Selectedly translated by Wu Liangzhu and
Yang Yongning.

THE THIRD NATIONAL POWDER METALLURGY TECHNICAL MEETING HELD IN ANSHAN

The Chinese Society of Metals held the third national powder metallurgy technical meeting on October 13-17, 1982 in Anshan, Liaoning. There were 139 experts, scholars, and engineers from 81 organizations of related departments from 25 provinces, cities, and autonomous regions, as well as the research, production, and design units in the Academy of Science, and higher learning institutions attending this meeting.

Professor Huang Peiyun, who is the Vice Chairman of the Chinese Society of Metals, and Associate Professors Li Xianlu and Lai Yihe, who are the Vice Chairmen of the Powder Metallurgy Academic Committee were in charge of this meeting. Associate Secretary in Chief, Wu Luqin, of the Chinese Society of Metals, Vice Chief, Wang Jingheng of the iron and steel office in the Metallurgy Department, Vice Chairman Zhou Gang of the Economics Committee of Liaoning, and Assistant Manager Ji Sun of Anshan Iron and Steel Company all attended and spoke at the meeting.

Professor Huang Peiyun gave the opening address. He outlined the status of the production, research and application of metallic powders since the 1978 meeting at Qinhuang Island and the 1980 in Jingsiang. The production of iron powder has already recovered somewhat from the lowest point. The research of the technology and equipment of the secondary reduction of iron powder and its applications in production have obtained better results. The quality of iron powder has greatly improved. The types are increased. Its applications are expanding. He also pointed out that this was the first time in our country that such an academic activity included non-ferrous metal powders. From now on, we have to strengthen the activities in this area. Both iron based powders and non-ferrous powders must be developed fully.

The major objectives of this academic meeting were to:

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- 1) exchange and discuss academic papers related to the metal powder special field;
- 2) discuss the aspects of powder metallurgy and welding strips, as well as the status of the production of non-ferrous metal powders and the developmental direction;
- 3) present and discuss suggestions to rationalize the development of our metal powder special field, and proceed with technological

inquiry; 4) discuss the national standard draft of the reductive iron powder used in powder metallurgy; and 5) discuss the plan of academic activities in the metal powder special field between 1983-1985.

Comrade Li Xianlu made an academic presentation on the "Current Status and Development of the Iron Powder Industry In and Out of the Country." Manager Lu Fuyuan of Anshan Steel Comprehensive Utilization Company reported on "The Production of Iron Powder at Anshan Steel Plant and Its Development Plan." Associate researcher Jin Dakang of Shanghai Metallurgical Research Institute of Chinese Academy of Science analyzed the problems by reporting on the paper entitled, "Investigation of the Iron Powder Quality Problems in Our Country From the Comparison of the Characteristics of Several Reductive Iron Powders Produced In and Out of Our Country."

The meeting received 67 papers from various units. In addition to the exchanges at the meeting, it was further divided into three special field groups according to the contents of the paper. They were reducing iron powders used in powder metallurgy, iron powders used in welding strips and iron powder obtained by technologies such as atomizing, and non-ferrous metal powders.

The representatives at the meeting believed that, after two years of work, some of the reducing iron powders have reached or are near the technical specifications of some of the brand name iron powders abroad. However, the annual production capability domestically is only twenty thousand tons. Furthermore, there exist problems such as small production scale, scattered location, outdated production technology and equipment, and high cost. From now on, we should grasp the problem of constructing modern iron powder plants. In the area of non-ferrous metal powders, the development in our country is relatively fast. The productivities of aluminum powder, zinc powder, copper powder, nickel powder, and titanium powder are relatively large. The annual total production has already reached nearly ten thousand tons.

During the meeting, the draft of the national standard for the reducing iron powder used in powder metallurgy was discussed. The membership meeting of the metal powder special field of the powder metallurgy academic committee was called. Anshan Steel

Comprehensive Utilization Company also held an exhibition of powder metallurgical technologies. In addition, two technical assistance sessions were held for the iron powders produced and developed by Anshan Steel and Maoming.

The representatives attending this meeting considered that the meeting was lively and active. The academic atmosphere was very thick. The accomplishments have been great. It demonstrated the determination to turn academic papers into productivity.

Vice Secretary-in-Chief of the Chinese Society of Metals, Comrade Wu Liqin Spoke at the closing ceremony. Finally, Comrade Lai Yihe gave the closing address of the meeting. The Fourth National Metal Powder Academic Meeting will be held in Chengdu in the fall of 1984.

(Gao Yiping)